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July 23, 2012

VIA ELECTRONIC DELIVERY

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, SW
Room TWA325
Washington, DC 20554

Re: Notice of *Ex Parte* Communication of PTC-220 LLC
WT Docket Nos. 11-79

Dear Ms. Dortch:

PTC-220 LLC ("PTC-220"), by and through its counsel, hereby submits the attached slides regarding positive train control that were presented in a meeting among various railroad operators on July 10, 2012, in Chicago, Illinois. These slides were provided to Richard Arsenault, Chief Counsel of the Mobility Division of the FCC's Wireless Telecommunications Bureau, on Thursday, July 19, 2012, at his request.

Pursuant to Section 1.1206(b) of the Commission's rules, I am filing this notice electronically in the above-referenced dockets. Please contact me directly with any questions.

Respectfully submitted,

/s/ Michele C. Farquhar

Michele C. Farquhar
Counsel to PTC-220 LLC

Partner
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PTC-220, LLC Overview

July 10, 2012

History

- Concept is to secure spectrum to support interoperable PTC
  - Wireless connectivity had been one of the “Achilles Heels” of PTC development efforts to date
  - 160 MHz and 900 MHz spectrum would not support PTC needs due to multitude of issues- technical, capacity, and timing
- Formed by NS and UP in late 2007
  - Original purchase of 280 kHz of nationwide 220 MHz spectrum
  - Various nationwide licenses and aggregated regional licenses

History

- Joined by BNSF and CSX in early 2010
  - BNSF spectrum added 100 kHz of nationwide spectrum
- Joined by CN, CP, and KCS in 2011 bringing total Membership to 7 equal owners
- All Members will have leases to allow use of PTC-220 spectrum
- PTC-220 provides spectrum, lease holders provide infrastructure
- Working to support spectrum needs for others through lease arrangements

Organization

Consists of multiple committees:

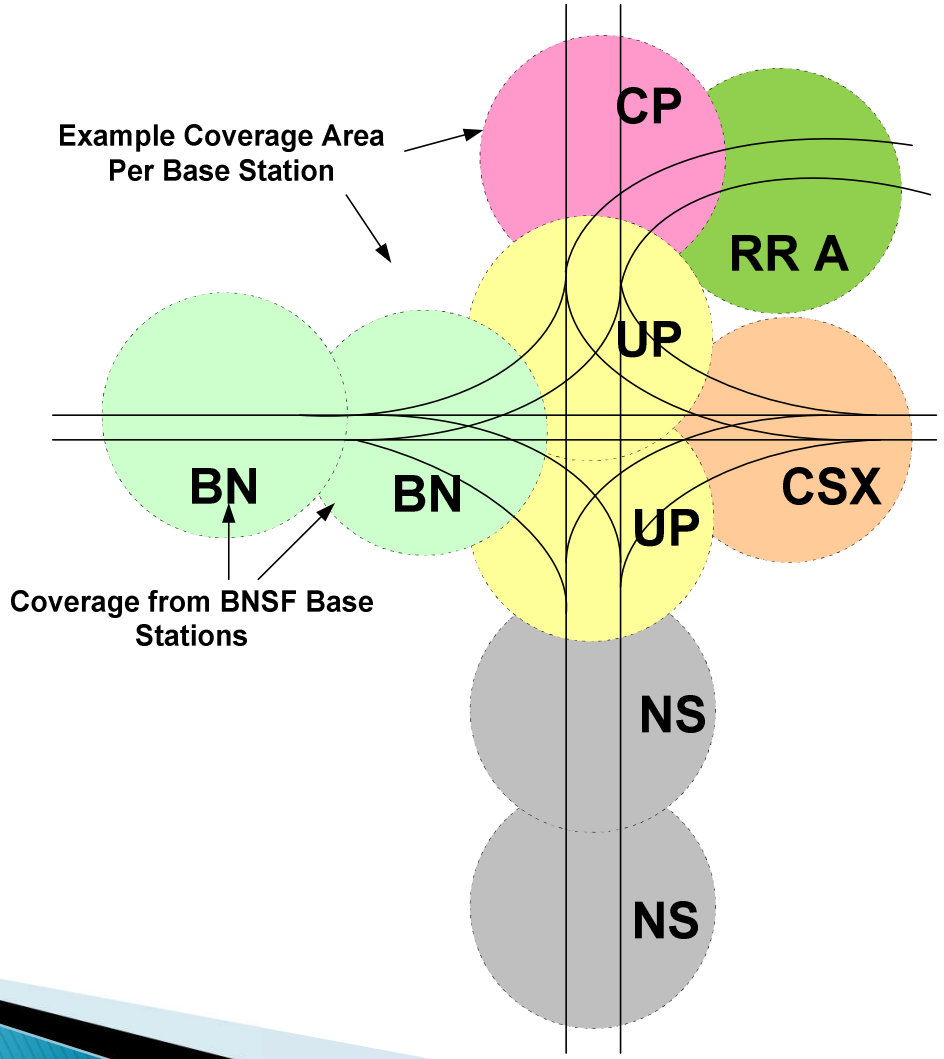
- Management Committee
  - Business and Administrative functions concerning the ongoing operation of the LLC.
- Spectrum Management Committee (SMC)
  - Engineering and Administrative functions related to the “care and feeding” of the spectrum holdings.
- Other
  - Finance and Administration
  - Law
  - Tax

Shared Use Agreement

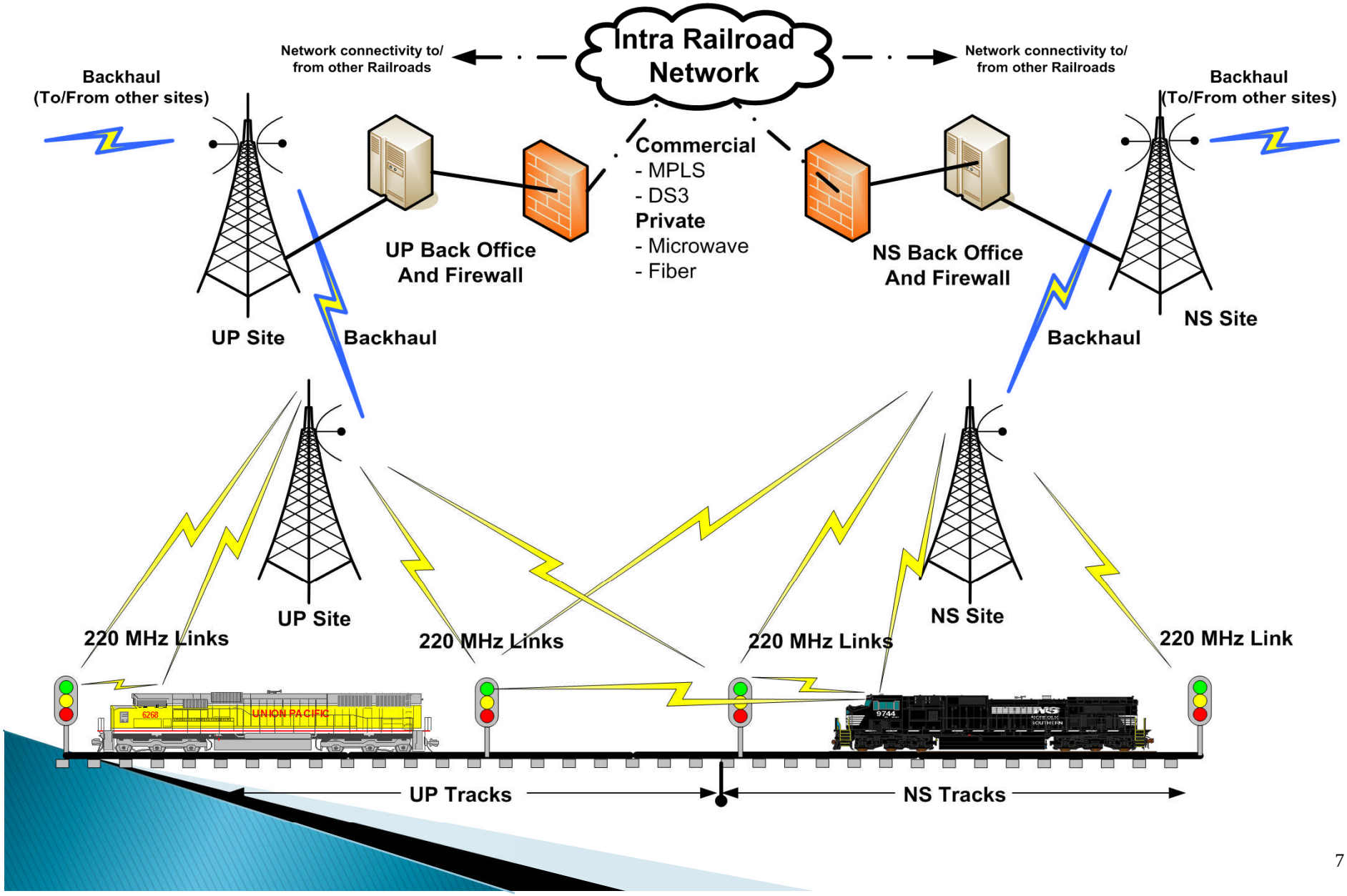
- Describes the “Rules of the Road” for PTC-220 spectrum use
  - Primary Use- PTC traffic using ITCnet channel access protocol
  - Secondary Use- Non-PTC traffic and non-ITCnet
  - Interference mitigation
  - Construction Plan
  - Shared use of infrastructure
  - Capacity loading projections
  - Congestion mitigation
    - Monitoring and Projections
    - Additional Spectrum need
  - Dispute resolution

Shared Infrastructure

Example Joint Operations Diagram
LLC Members and one Non-Member User



PTC 220 MHz Lessee Infrastructure and Network Connectivity Diagram



Non-Member Access to Spectrum

- PTC-220, LLC is not a profit center. Charges will be assessed to non-Members reflecting a reasonable allocation of investment and other costs.
- Members represent the large majority of mandated PTC deployment based on mileage
- Fees may be off-set or eliminated by contributions of Spectrum by an applicant.

Non-Member Access to Spectrum

Guiding Principles

- Non-members will pay their fair share
  - Reasonable allocation of costs for access to PTC-220 Spectrum and services
- Lease cost considerations will include:
  - Acquisition cost of 220Mhz spectrum (usable for PTC)
  - Contributions of spectrum or other lessee contributions
  - PTC-220 Ongoing operating costs
  - Return on investment
- "Keep it simple"
  - Lease rate calculations should be simple and easy to understand
    - Number of base station locations required to cover PTC track
  - Administrative effort to determine lease rates should be minimized

PTC-220, LLC

Management and Use of PTC Spectrum

PTC: the search for Spectrum

44 MHz
160 MHz
220 MHz
450 MHz
900 MHz
Cellular
Satellite

All of these bands (and more) have been considered for PTC

PTC: the search for Spectrum

44 MHz
160 MHz
220 MHz
450 MHz
900 MHz
Cellular
Satellite

VHF best spectrum fits existing Base Station facility spacing

PTC: the search for Spectrum

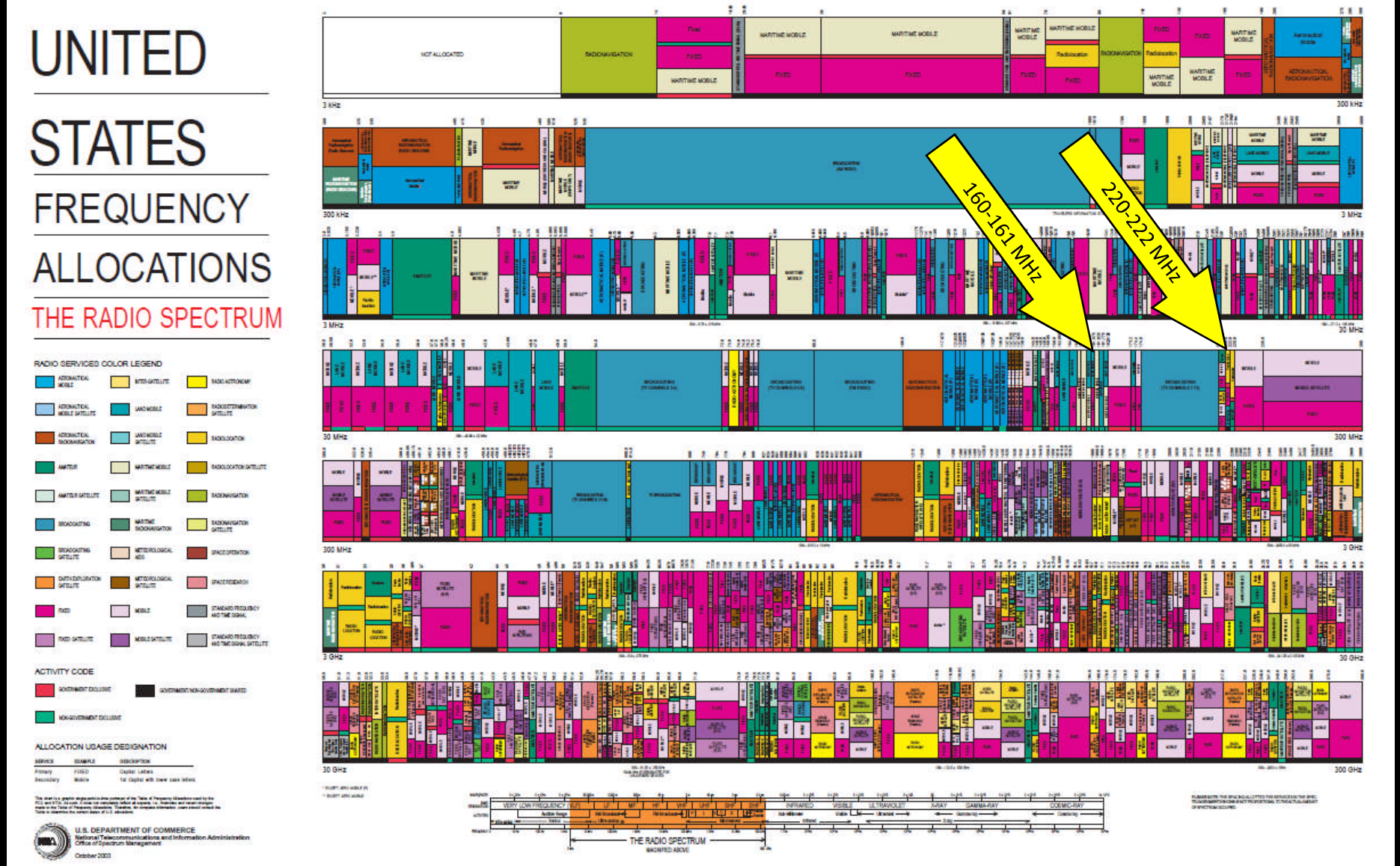
2005 AAR Study Identified 160 MHz as the only realistic place for PTC

PTC: the search for Spectrum

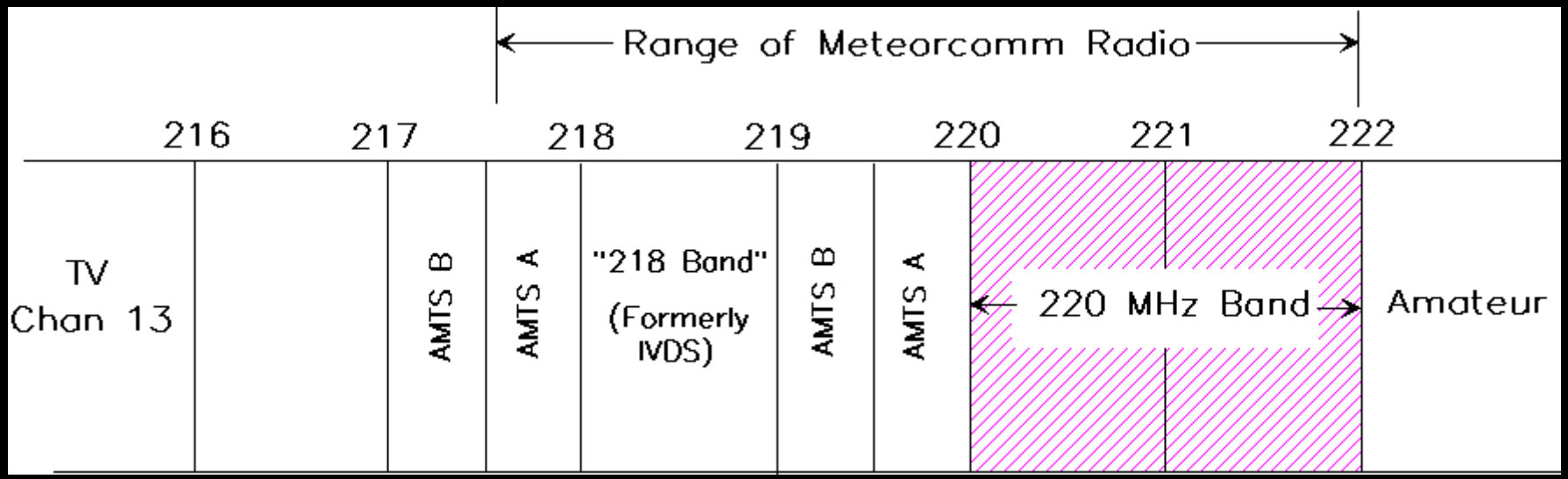
44 MHz
160 MHz
220 MHz
450 MHz
900 MHz
Cellular
Satellite

Serendipity: In 2007 significant 220 MHz spectrum went on the market

- Nationwide licenses
- Relatively unencumbered


UNITED
STATES
FREQUENCY
ALLOCATIONS
THE RADIO SPECTRUM
RADIO SERVICES COLOR LEGEND
ACTIVITY CODE
ALLOCATION USAGE DESIGNATION
U.S. DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration
Office of Spectrum Management
October 2003
160-161 MHz
220-222 MHz
THE RADIO SPECTRUM

ITCNet Appropriate Bands



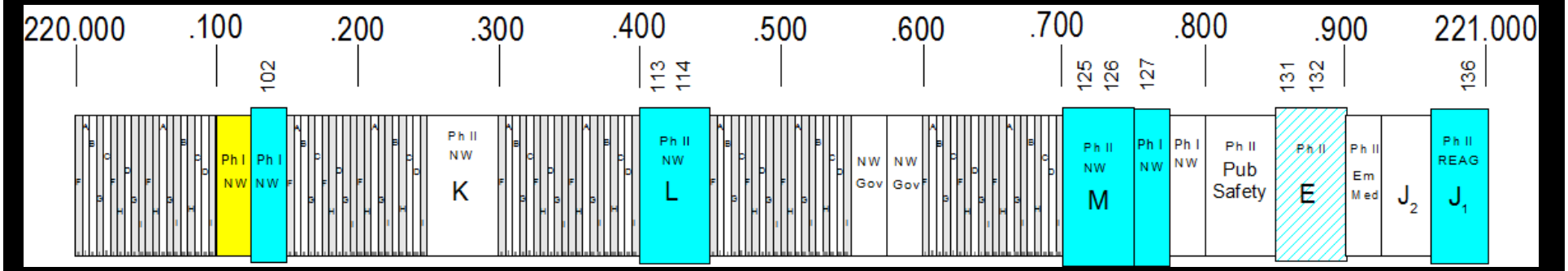
218 Band

- Formerly Interactive Video & Data Service
- Troubled history
- At least one restructuring
- Auction 89 on hold

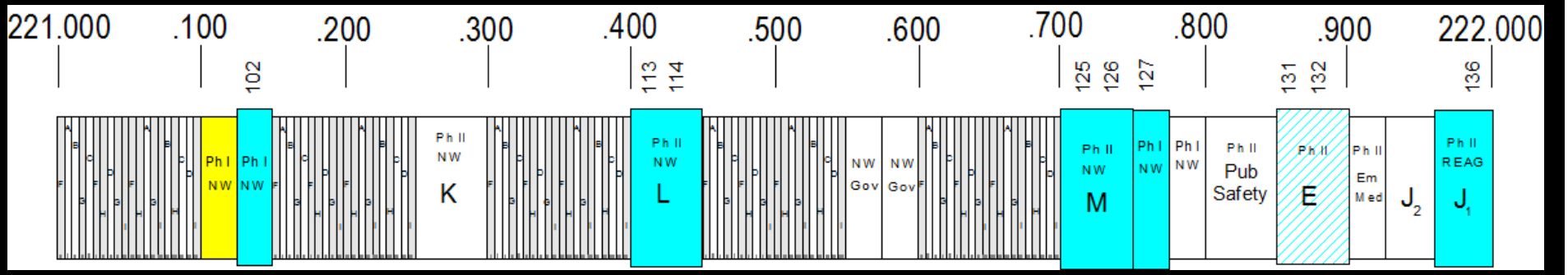
AMTS Bands

- Automated Marine Telecommunications System
- Significant partitioning & disaggregation
- Incumbents
- Some troublesome rules

“Base Side”—220-221 MHz



“Mobile Side”—221-222 MHz



Waivers Needed to Make Spectrum PTC Ready

FCC Rule Waivers in Place

- Buildout deadlines extended
- No need for Station ID
- Commercial Use requirement waived
- Can use Base Stations on “Mobile Side” frequencies

Potential New Waiver Request

- Relief from power/antenna height restrictions on 221-222 frequencies

Congested PTC Area Design Strategy

- Congested areas require special design considerations
  - Multiple PTC Operators
  - "2-D" coverage requirement
  - High message density
  - High channel loading
- Interoperability is necessary for seamless & efficient operation
- Spectrum is a limited and dear commodity
  - Probably isn't enough for independent, isolated systems
- Congested areas best done by a single shared network
  - Maximizes efficient use of spectrum
  - Minimizes duplication and overall infrastructure need
  - Minimizes and coordinates interference from other PTC stations
  - Allows optimal RF network layout

Congested PTC Area Design Strategy

Design Process:

- Define limits of Congested Area
- All PTC operators submit candidate Base Station sites
- The optimal subset of stations is selected for the RF network
- Selected sites are built and operated by their owners
- All stations are potentially shared stations

METROLINK

Los Angeles PTC Radio Network Design
July 10, 2012

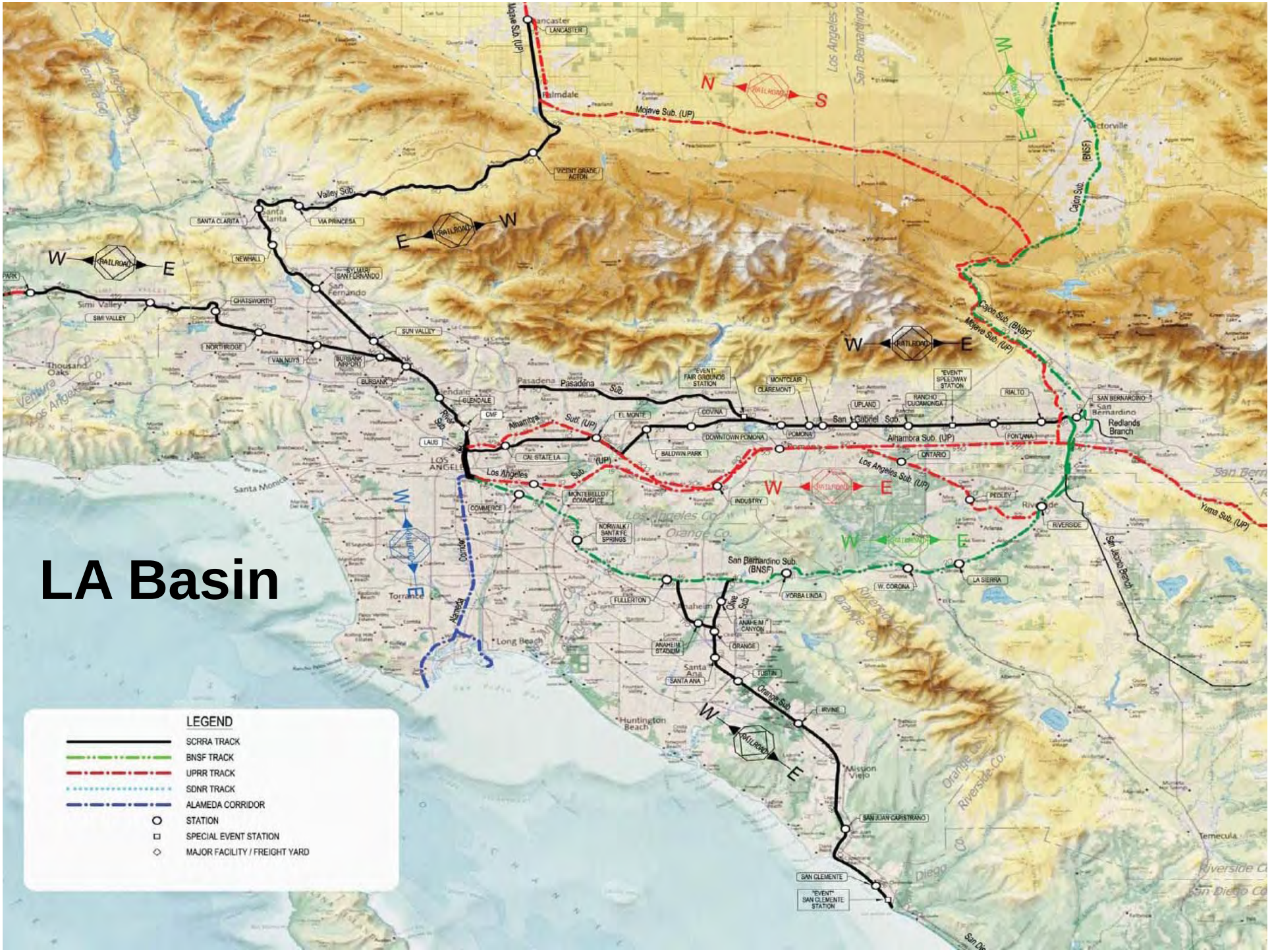
Presented By: Joe Zerzan / Paul Wadum

PARSONS

Positive Train Control

Discussion Points

- Introductions
- The LA Basin
  - Metrolink
  - BNSF
  - UP
- RF Propagation
- Traffic Study
- Frequency Coordination
- Interoperability Radio Testing


LA Basin
LEGEND
SCRRA TRACK
BNSF TRACK
UPRR TRACK
SDNR TRACK
ALAMEDA CORRIDOR
STATION
SPECIAL EVENT STATION
MAJOR FACILITY / FREIGHT YARD
Mojave Sub. (UP)
Valley Sub
Pasadena Sub
Alhambra Sub. (UP)
Los Angeles Sub. (UP)
San Gabriel Sub.
Cajon Sub. (BNSF)
San Bernardino Sub. (BNSF)
Redlands Branch
Yuma Sub. (UP)
San Jacinto Branch
Orange Sub
Olive Sub
Alameda Corridor
LANCASTER
PALMDALE
VICENT GRADE/ ACTON
SANTA CLARITA
VIA PRINCESA
NEWHALL
SYLMAR/ SAN FERNANDO
CHATSWORTH
SIMI VALLEY
NORTHRIDGE
VAN NUYS
BURBANK AIRPORT
BURBANK
SUN VALLEY
GLENDALE
CMF
LAUS
CAL STATE LA
MONTEBELLO/ COMMERCE
COMMERCE
NORWALK/ SANTA FE SPRINGS
FULLERTON
ANAHEIM CANYON
ANAHEIM STADIUM
ORANGE
TUSTIN
SANTA ANA
IRVINE
SAN JUAN CAPISTRANO
SAN CLEMENTE
"EVENT" SAN CLEMENTE STATION
"EVENT" FAIR ORDUNOS STATION
"EVENT" SPEEDWAY STATION
MONTCLAIR
CLAREMONT
UPLAND
RANCHO CUCAMONGA
RIALTO
SAN BERNARDINO
EL MONTE
COVINA
DOWNTOWN POMONA
POMONA
FONTANA
ONTARIO
BALDWIN PARK
INDUSTRY
PEDLEY
RIVERSIDE
LA SIERRA
W. CORONA
YORBA LINDA
Victorville
Lancaster
Palmdale
Santa Clarita
Simi Valley
Thousand Oaks
Pasadena
Los Angeles
Santa Monica
Long Beach
Torrance
Huntington Beach
Mission Viejo
Temecula
Riverside
San Bernardino
Los Angeles Co.
Orange Co.
Riverside Co.
San Diego Co.
Ventura Co.
RAILROAD
N
S
E
W

Coordinated Design Approach

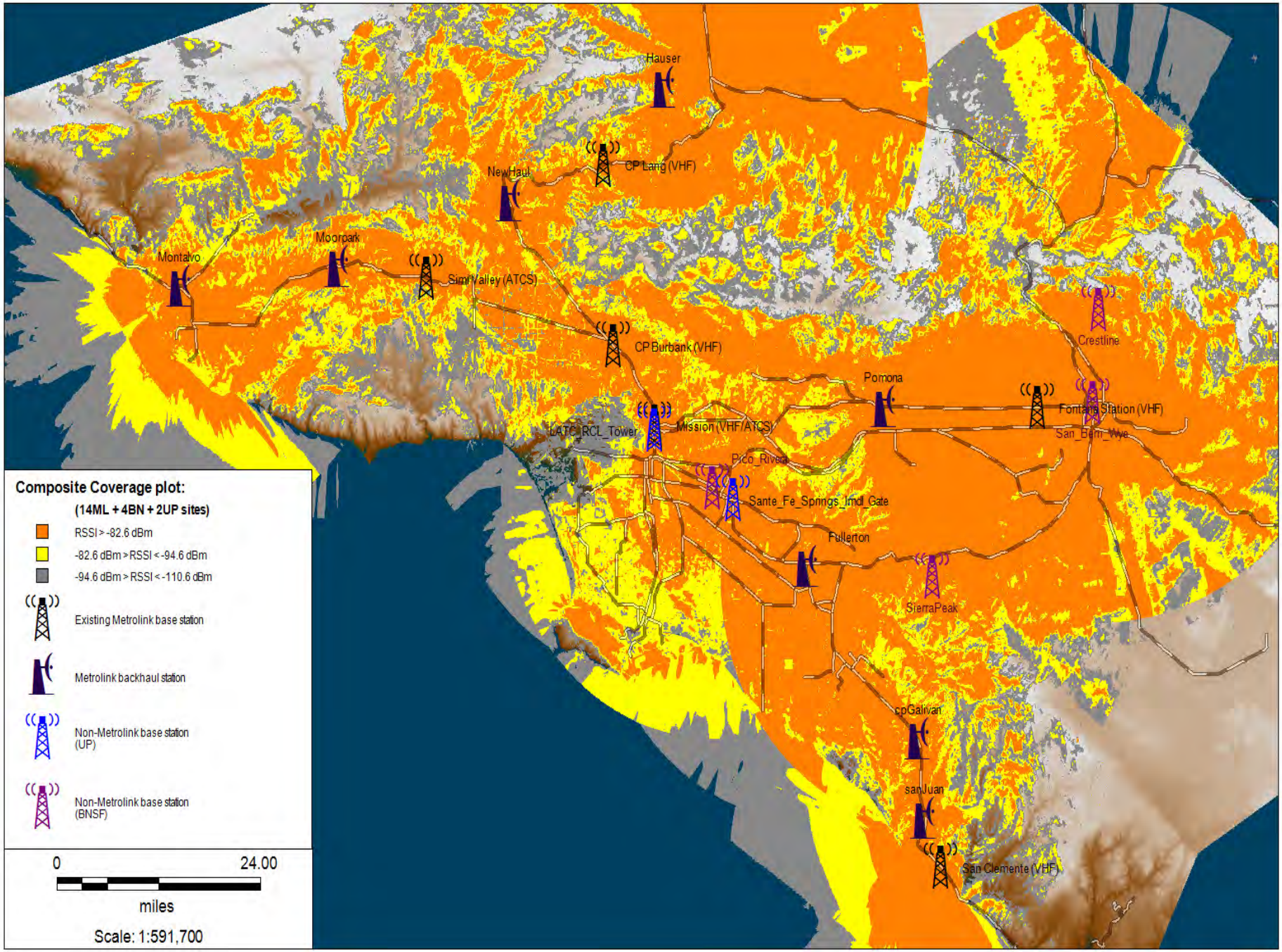
- Define Communication Stakeholders
  - UP, BNSF, Metrolink
  - Define Responsibilities
- Set Up Weekly Meetings (Working Group)
  - LA Regional RF Design Meeting
  - Identify Chair Person
  - Establish Design Requirements
    - Criteria for Base Station Selection
    - Wayside & RR Assets for PTC
- Meet Face to Face Quarterly
  - Goal Oriented Discussion

METROLINK


Santa Barbara County
Ventura County
Los Angeles County
San Bernardino County
Orange County
Riverside County
San Diego County
LA Boundary
Santa Paula Branch
Valley Sub.
Ventura Sub.
Pasadena Sub.
San Gabriel Sub.
River Sub.
Los Angeles Sub. (UP)
San Bernardino Sub. (BNSF)
Orange Sub.
San Diego Sub. (SDNR)
Perris Valley Line
Lancaster
Palmdale
Vincent Grade / Acton
Newhall
Sylmar / San Fernando
Burbank Airport
Glendale
LAUS
Commerce
Pomona
Riverside Downtown
Moreno Valley / March Field
Perris
South Perris
Anaheim / Canyon
Anaheim Stadium
Orange
Santa Ana
Tustin
Irvine
Laguna Niguel
San Juan Capistrano
San Clemente North Beach
San Clemente
Oceanside
Legend
SCRRA / Metrolink Track
BNSF Track
UPRR Track
San Diego Northern Track
Alameda Corridor Track
Station
Control Point
Major Facility / Freight Yard
Future Station
VHF/ATCS Base Station
PTC Backhaul Site
VHF/ATCS Base Station & PTC Backhaul Site
Microwave Antenna & PTC backhaul Site
METROLINK
SYSTEM WIDE STATIONS MAP
10/01/2010
SAN DIEGO COUNTY

Technical Design Approach

- Mentum Planet
  - CRC Predictive Model with WGS 84 Geodetic Datum
  - Resolution Between 20m – 30m
  - One Project File
- Tuned Model
  - Drive Test Completed Different Clutter Types Throughout the SCRRA Territory
- Mountain Top Sites Were Used at a Minimum Due to the Complexity Described by Meteorcomm.
  - BNSF Sites Sierra Peak and Crestline Included in the Model.
  - Metrolink Site Hauser Mtn is Proposed Due to Isolated Location.


Hauser
CP Lang (VHF)
NewHall
Moorpark
Montalvo
Simi Valley (ATCS)
CP Burbank (VHF)
Crestline
Pomona
Fontana Station (VHF)
San_Bern_Wye
LATC_RCL_Tower
Mission (VHF/ATCS)
Pico_Rivera
Sante_Fe_Springs_Imdl_Gate
Fullerton
SierraPeak
cpGalivan
sanJuan
San Clemente (VHF)
Composite Coverage plot:
(14ML + 4BN + 2UP sites)
RSSI > -82.6 dBm
-82.6 dBm > RSSI < -94.6 dBm
-94.6 dBm > RSSI < -110.6 dBm
Existing Metrolink base station
Metrolink backhaul station
Non-Metrolink base station (UP)
Non-Metrolink base station (BNSF)
0
24.00
miles
Scale: 1:591,700

Traffic Study

- 2020 Traffic Density
  - BNSF, UP, Amtrak & Metrolink
- TTCI 24-hour, 14-Day Traffic Simulation
- TTCI Traffic Study
  - Completed June 1, 2011
- Demand Study
  - Completed September 9, 2011
- Throughput Analysis
  - Completed September 16, 2011

Traffic Study

- Traffic data for every point within each base station's coverage area was extracted.

- To determine peak traffic in one frame, data for 3 second intervals was totaled and maximum 3-second traffic per base station was determined.

- Total traffic within every 3-second intervals were graphed into Histograms.

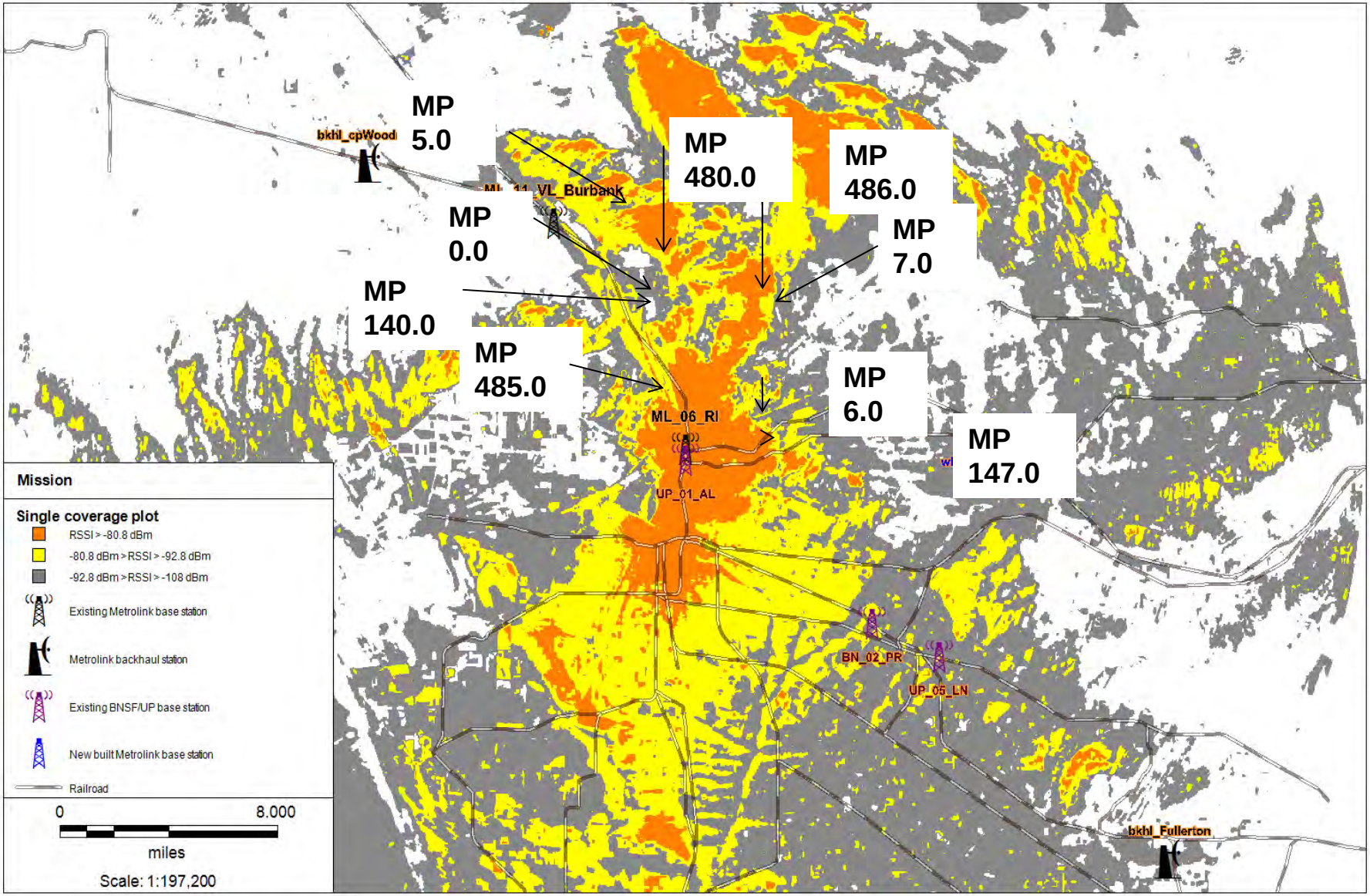
- Similarly Histograms for 15-second intervals (5 consecutive frames) was created.

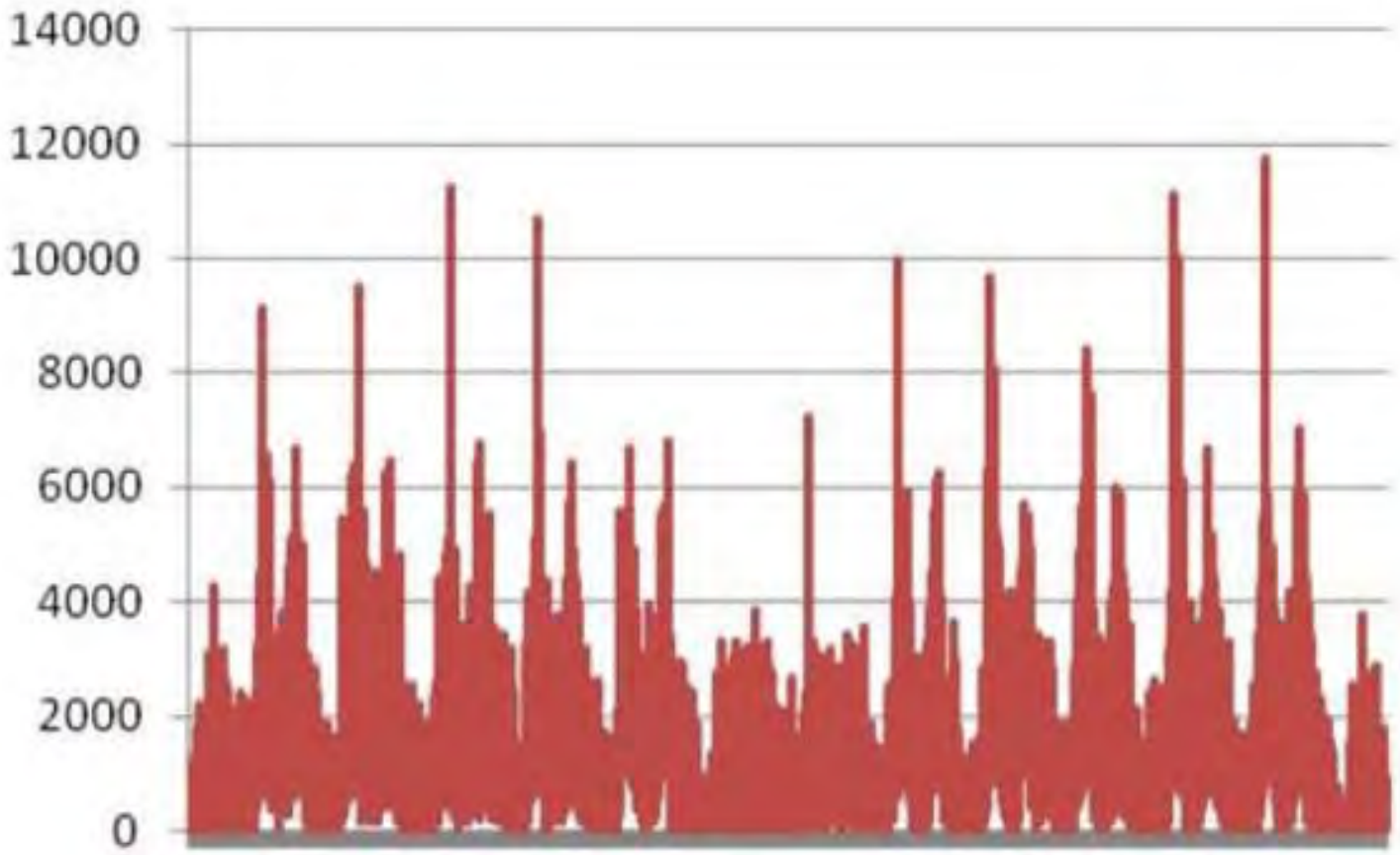
Traffic Study

- TTCI Traffic Study – Number ofData Points (MP)

1. Identify the Demand Per Base Station
2. Identify the Highest Peak Demand (worst case)
    1. 3 second (Super-frame size)
    2. Maximum Packet Size

METROLINK


MP 5.0
MP 480.0
MP 486.0
MP 0.0
MP 7.0
MP 140.0
MP 485.0
MP 6.0
MP 147.0
bkhl_cpWood
ML_06_RI
UP_01_AL
BN_02_PR
UP_05_LN
bkhl_Fullerton
Mission
Single coverage plot
RSSI > -80.8 dBm
-80.8 dBm > RSSI > -92.8 dBm
-92.8 dBm > RSSI > -108 dBm
Existing Metrolink base station
Metrolink backhaul station
Existing BNSF/UP base station
New built Metrolink base station
Railroad
0
8.000
miles
Scale: 1:197,200



LA Union (Mission) Base Station 15-second Histogram

Frequency Planning Criteria

- Make the most efficient use of the available 220 MHz spectrum to determine the minimum number of frequencies required to satisfy the desired channel interference (C/I).
- Minimize co-channel and adjacent channel interference.
- Maximize the number of Waysides under a base station.

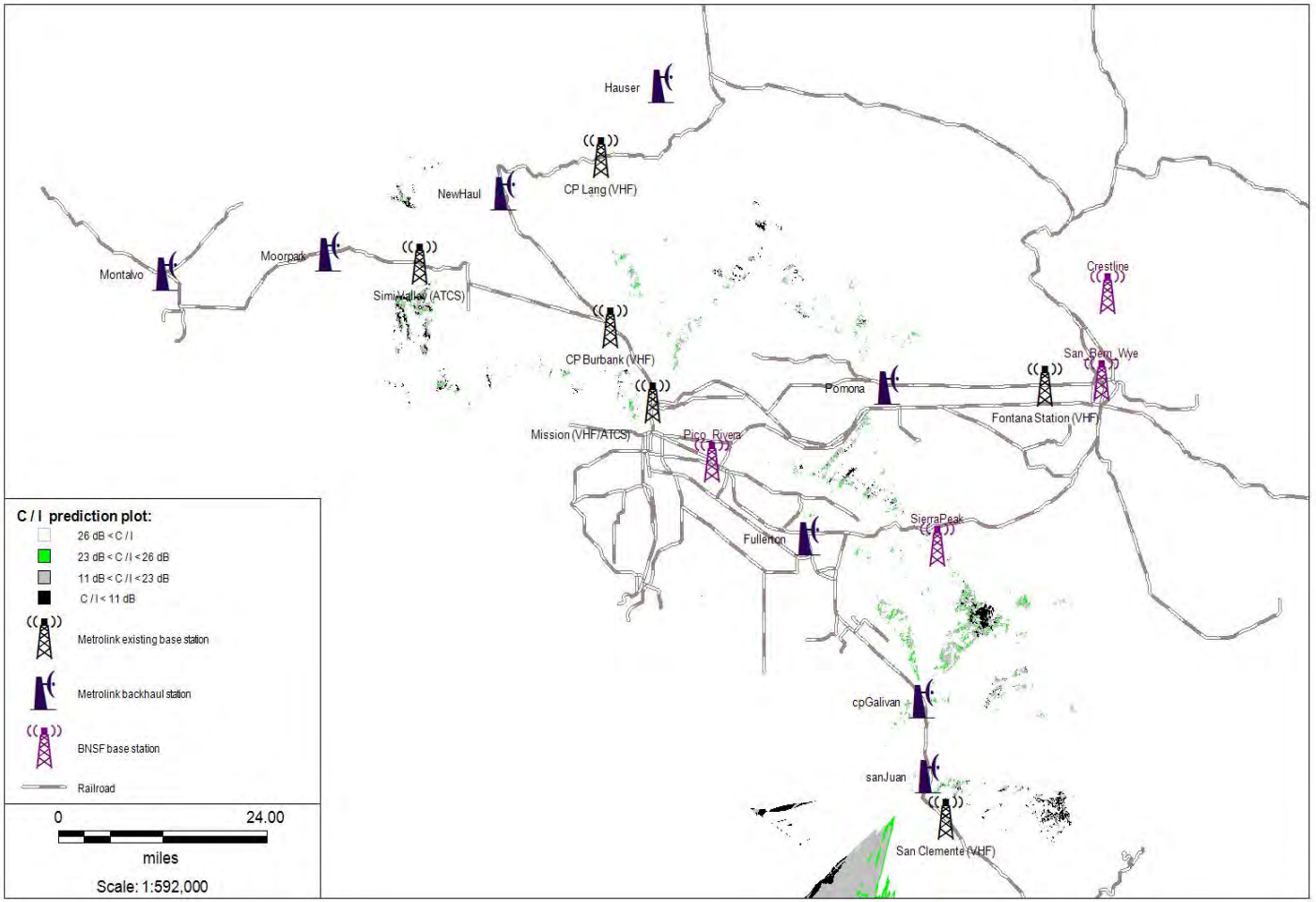
Frequency Planning Approach

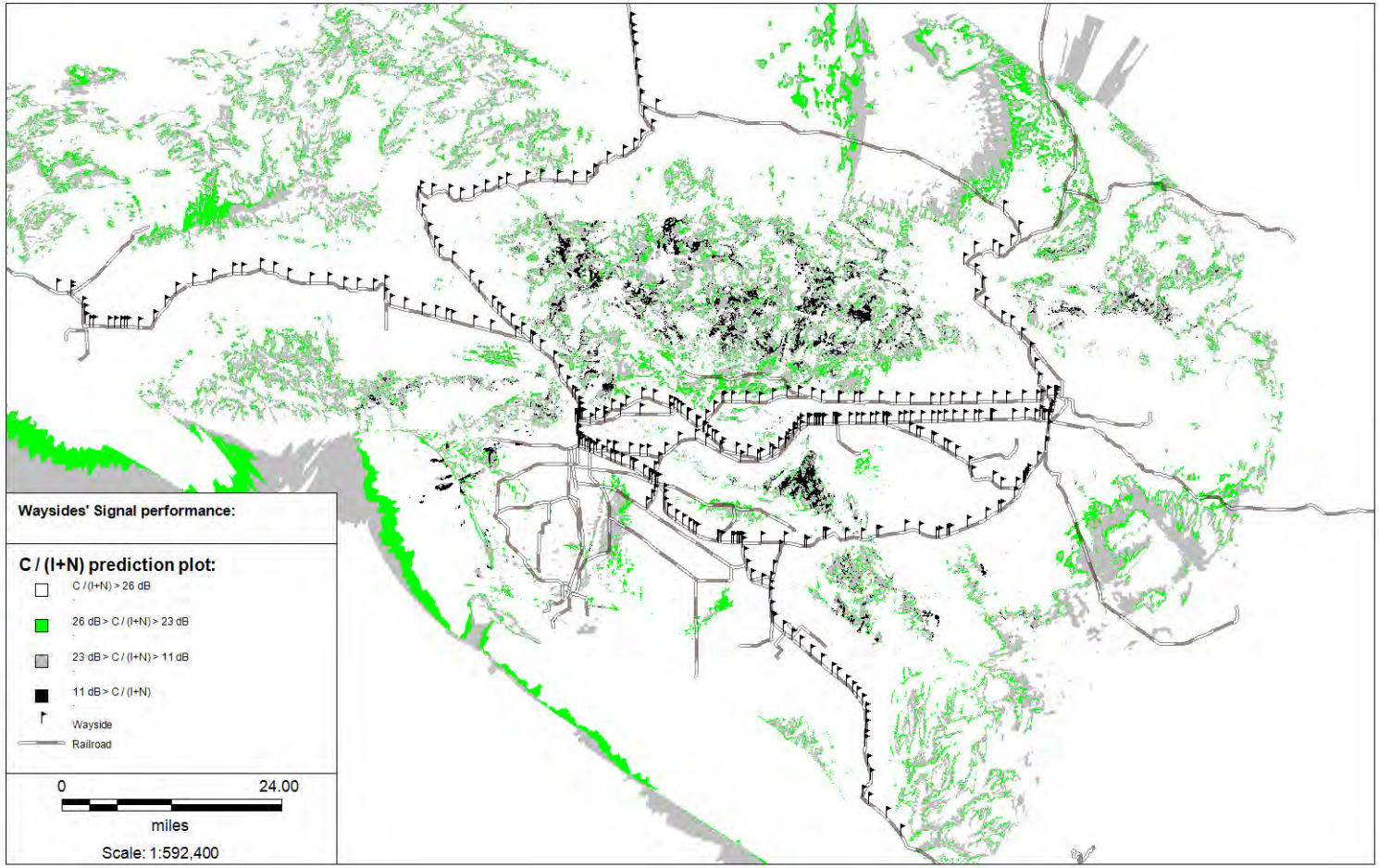
- Using Mentum Planet Automatic Frequency Planning (AFP) we will enter the required C/I.
- PTC 220 Frequencies = Assume 18 for LA Region
  - Nationwide Common Channel = 1
  - Base Station Local Channel = 8
  - Wayside Channel = 6
- Links to Create Channel Plans
  - Wayside ←→ Locomotive
  - Base ←→ Locomotive
  - Base ←→ Wayside

Frequency Planning Approach

- Remote Controlled Locomotives (RCL) use The 220 Frequencies
- Due to the disparity in transmitter power, adjacent PTC channels can severely disrupt RCL operation.
- The common channel was discovered to be adjacent to a dedicated RCL channel in the congested LA Union Station/Port of LA area
- This channel was changed for the RCL
- Consideration of impact to RCL will be factored into the frequency plan

Site ID	Sector ID	Carrier Number
bkhl_cpGalivan	1	155
bkhl_cpGalivan	2	156
bkhl_Fullerton	1	151
bkhl_Hauser	1	137
bkhl_Montalvo	1	149
bkhl_Moorpark	1	150
bkhl_Moorpark	2	151
bkhl_NewHaul	1	156
bkhl_Pomona	1	150
bkhl_Pomona	2	155
bkhl_sanJuan	1	156
bkhl_sanJuan	2	149
BN_01_CR_Crestline	1	138
BN_02_PR_PicoRivera	1	160
BN_03_SB_SanBernardino	1	149
BN_06_SierraPeak	1	137
ML_05_OR_San Clemente	1	150
ML_06_RI_Union	1	156
ML_06_RI_Union	2	150
ML_09_SG_Fontana	1	160
ML_09_SG_Fontana	2	151
ML_11_VL_Burbank	1	149
ML_13_VL_CPLang	1	160
ML_18_VN_Simi_Valley	1	155
ML_18_VN_Simi_Valley	2	160


Hauser
CP Lang (VHF)
NewHaul
Moorpark
Montalvo
Simi Valley (ATCS)
CP Burbank (VHF)
Crestline
San Bern. Wye
Pomona
Fontana Station (VHF)
Mission (VHF/ATCS)
Pico Rivera
Fullerton
SierraPeak
cpGalivan
sanJuan
San Clemente (VHF)
C / I prediction plot:
26 dB < C / I
23 dB < C / I < 26 dB
11 dB < C / I < 23 dB
C / I < 11 dB
Metrolink existing base station
Metrolink backhaul station
BNSF base station
Railroad
0
24.00
miles
Scale: 1:592,000

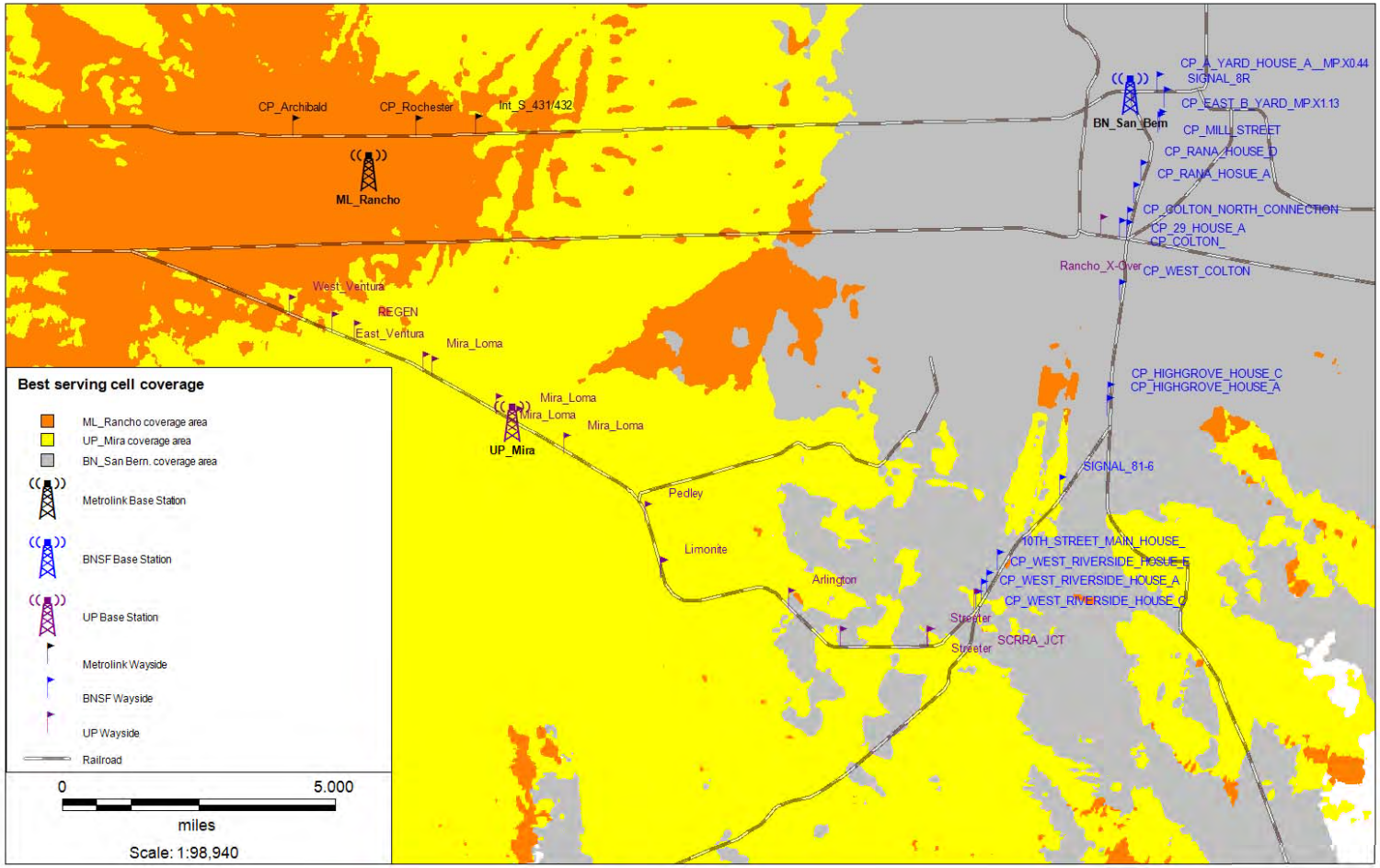

Waysides' Signal performance:
C / (I+N) prediction plot:
C / (I+N) > 26 dB
26 dB > C / (I+N) > 23 dB
23 dB > C / (I+N) > 11 dB
11 dB > C / (I+N)
Wayside
Railroad
0
24.00
miles
Scale: 1:592,400

Phase I RF Testing

Schedule

- Phase I RF Test- April 16th to April 19th 2012: COMPLETE
  - The objective of the RF testing was to verify RF coverage and throughput, measure system performance, and examine RF links between the mobile and fixed radios.
- Phase II Interoperability Test- August 2012:
  - The objective of the interoperability test is to achieve successful transmission of messages between the different locomotive radios and their respective Back Office Servers, through other railroad ITCMs.

Phase 1 Test Bed



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Positive Train Control

Phase 1 Test Cases

- PTC Radio Operation Verification
- Configuration (CIM Setting)
- Radio ID
- TX Power
- Antenna System Sweep for Base Stations and Waysides
- Validation of RF Coverage from 4 BNSF Sites, 1 UP site and 1 Metrolink Site
- RF Performance Metric – verification of 10-4 BER in coverage area
- Validation of WSRS per RF Coverage study – BNSF has identified 8 locations requiring WSRS
- Sierra Peak Coverage Concerns Relating to “Mountain Top” Site Brought Forward by MCC
- Locomotive to Base Selection with “Mountain Top” sites
- Too Much Overlap in RF Coverage
- WIU to Locomotive (direct path) Range and Error Rate
- Base Station to Locomotive Range and Error Rate
- Base Station Handoffs

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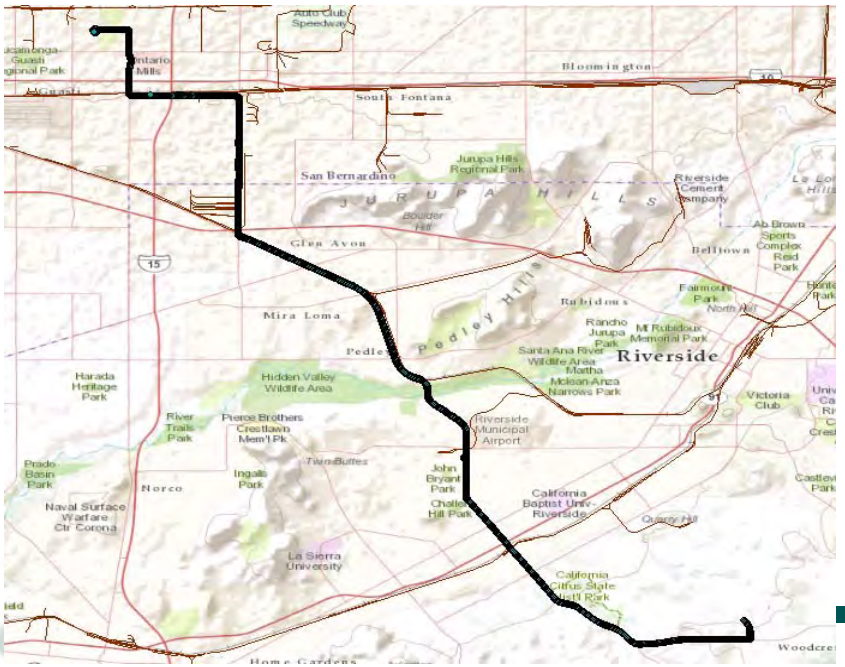
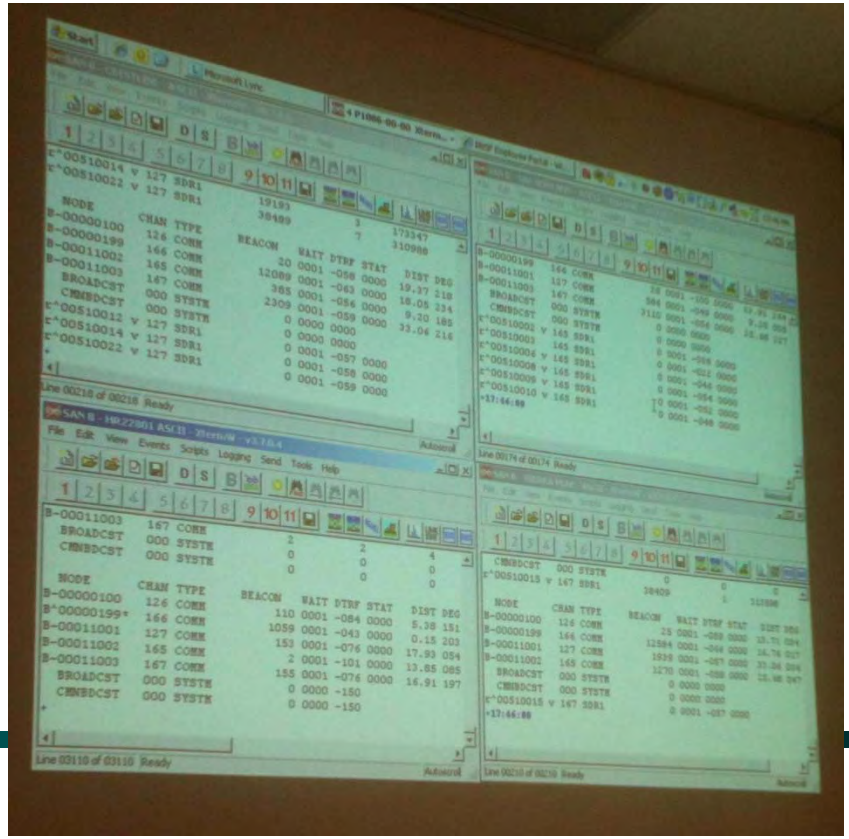
Phase 1 Testing

- **BER Measurement**
  - For this test, each hy-rail drove a pre-planned route within Sierra Peak and Crestline base station coverage areas. First Sierra Peak base radio was set to test mode and BER was logged on XtermW, then it was switched to Crestline.





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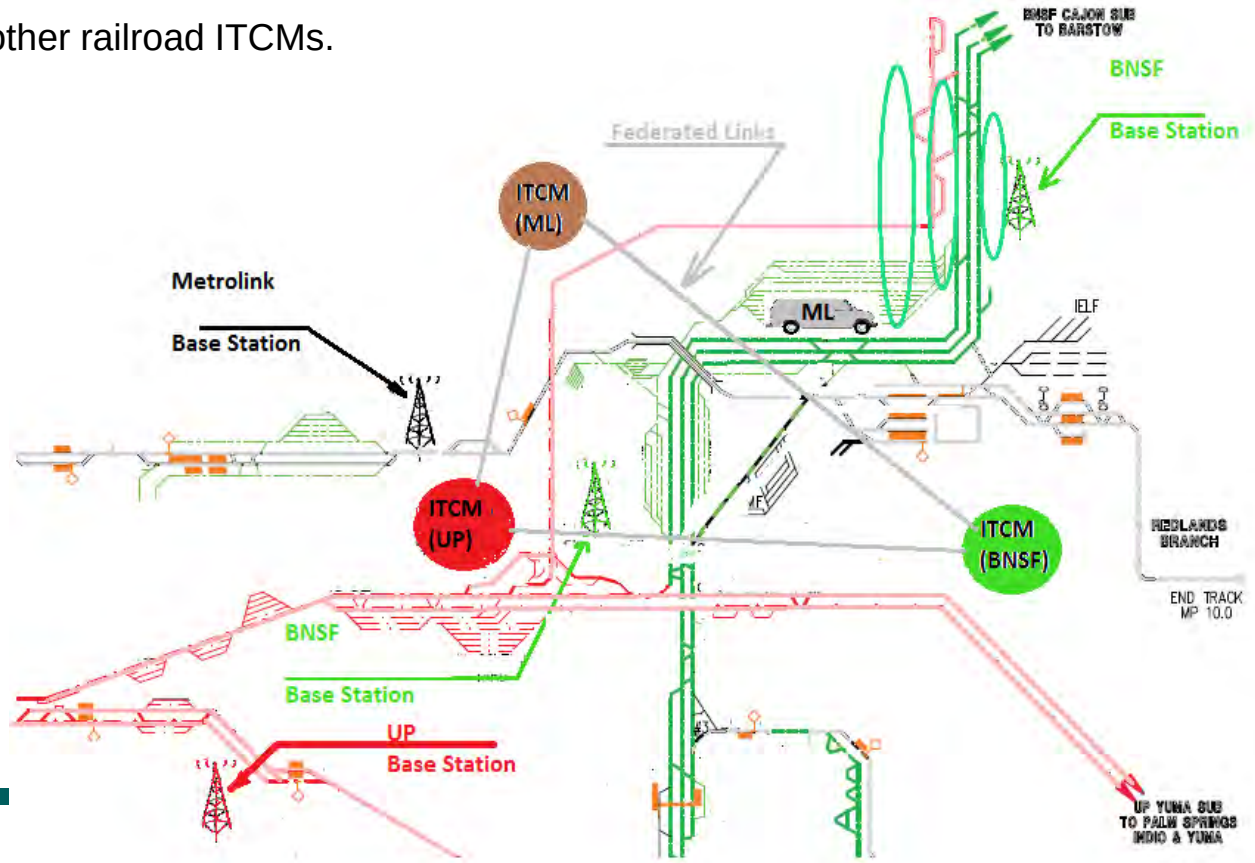
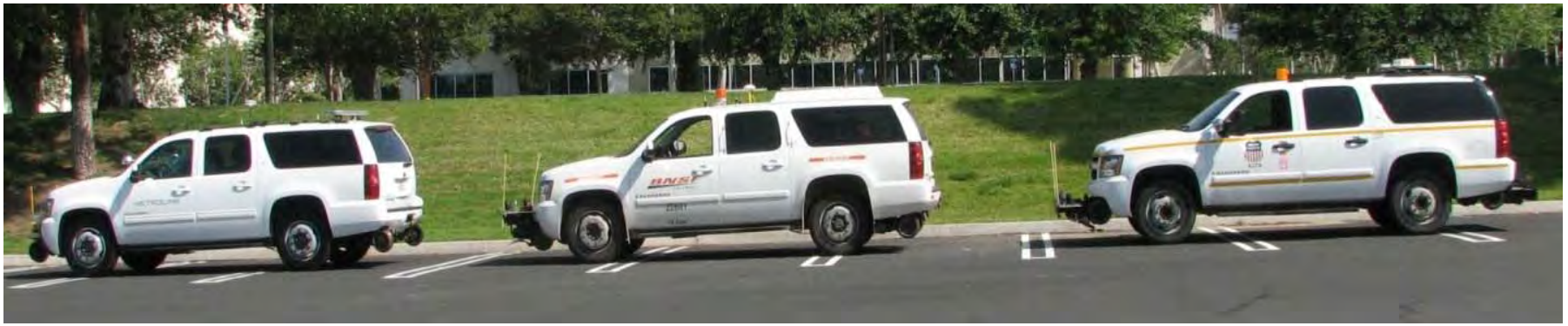
Interoperability Phase 2 Testing

- **Objective**
  - The objective of the interoperability test is to achieve successful transmission of messages between the different locomotive radios and their respective Back Office Servers, through other railroad ITCMs.



Phase 2 Test Cases

- Hy-rail sends messages to ITCM via other ITCMs
- ITCM sends messages to Hy-rail via other ITCMs
- WIU sends a status message to ITCM via other base stations
- Base Station Hand-offs between ITCM's.
- Test Exit Criteria
  - The identified test cases have been executed and passed
  - There are zero Severity 1 and Severity 2 defects



Thank You

RF Spectrum Coordination and Urban Area Design for PTC220, LLC

Alan Polivka

AVP Communications & Train Control

July 10, 2012

TTCI's Project for PTC220, LLC

For the largest Urban Areas in the US, where more than two railroads must operate under PTC, TTCI's tasks are to:

- **Estimate PTC 220 MHz Spectrum Needs**
  - Communications load (demand) modeling & analysis
    - Based on train movements & infrastructure

Preliminary RF needs estimate done for Chicago;

Now doing St L, KC, & Philly

- **Configure PTC Data Radio Networks**
  - Base station site selections
  - Base & WIU configuration (antenna type, height, azimuth, ERP)
  - Frequency assignments & reuse
  - Timeslot assignments to WIUs
- **Develop & Apply FAMS220 Database to support Licensing & Nationwide RF Analysis**
- **Interface with FCC as needed**
- **Monitor Network Loading (future)**

Who is TTCI?

High Tonnage Loop (HTL)

- 2.7-mile loop, three 5° curves, one 6 ° curve
- Main use – HAL studies
- Test bed for various premium track components
- 25 MGT/month in controlled environment

- **~$25 million/yr Research**
- **>100 Engineers & Scientists**
- **State of Art Modeling Tools**

Wheel/Rail Mechanism Track (WRM)

- 7.5°, 10°, and 12° curving performance tests
- Dynamic curving tests
- Lubrication studies

World's Largest Dedicated Railroad Test & Research Facility

Transit Test Track (TTT)

- 9.1-mile loop
- 80 mph max speed
- DC electrified third rail
  - Up to 1150 volts
  - Up to 12,000 amps

Crash Wall

Railroad Test Track (RTT)

- 13.5-mile loop
- 1°-15' curve and four 50' curves
- Main use – HAL studies
- Maximum speed 165 mph
- 12.5-, 25- & 50-kV overhead catenary

Precision Test Track (PTT)

Multi-use track for railcar testing

- Pitch and bounce
- Twist and roll
- Yaw and sway
- Car impact
- Miscellaneous studies

- **Qualification Testing**
- **Conformance / Spec Testing**
- **Endurance Testing**
- **Standards & Inspections**
- **PTC & Comms Test Bed**
- **Training Facilities, incl. Emergency Response**

Introduction

In September 2011, PTC220 tasked TTCI to develop a preliminary estimate of required RF spectrum for the Chicago area.

The following presentation provides a summary of that work.

TTCI's Process & Tools for PTC RF Network Design

Railroad Input Files
- Train Schedules / Consist
- Track, Signaling
- Speed limits & Restrictions

RTC Simulator

Train Movement Simulation

RTC Output Files
- Train Movements

TTCI Post-Processor

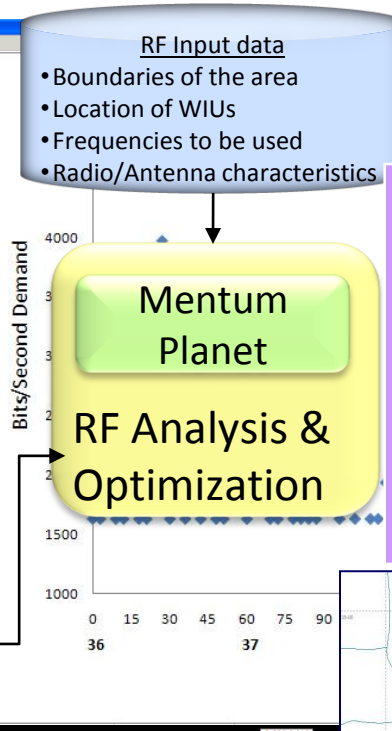
Msg Loading Simulation

Railroad PTC Message Traffic
- Number of Msg/Mile
- Bits/Sec per mile

RF Input data
- Boundaries of the area
- Location of WIUs
- Frequencies to be used
- Radio/Antenna characteristics

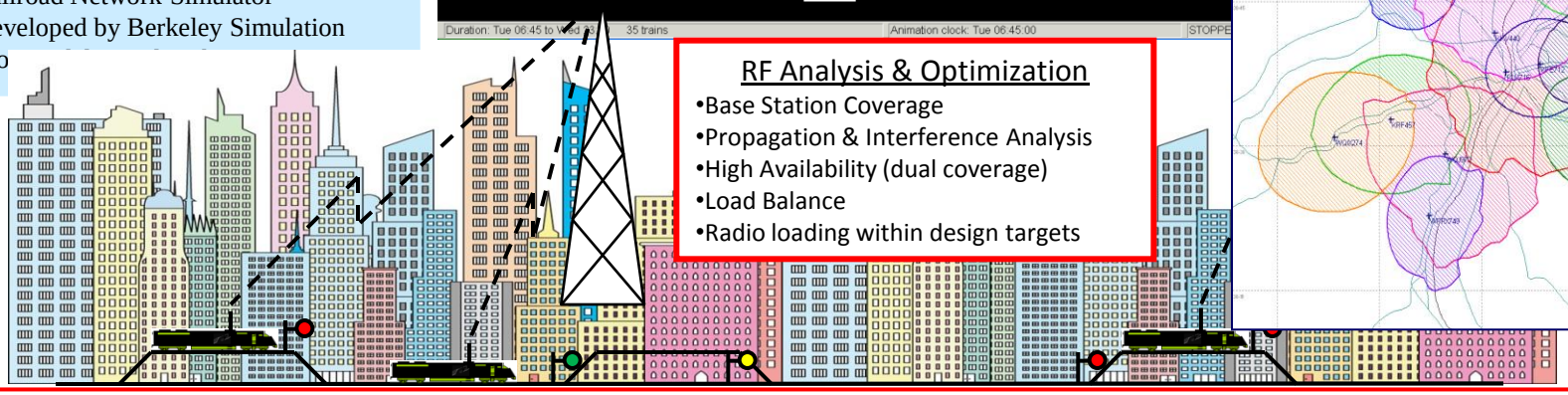
Mentum Planet

RF Analysis & Optimization

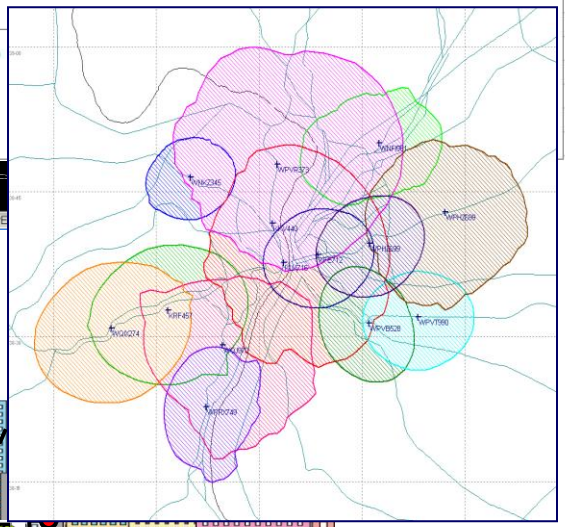


RF Design Plan & Deliverables
- Frequency Assignments
- List of selected Base Stations
- Individual Base Station Targets and Configuration
- Traffic Calculations
- Time slot allocation per channel
- Coverage / Interference Plots
- Service Contours

RTC (Rail Traffic Controller)
- Railroad Network Simulator
- Developed by Berkeley Simulation
- Mo

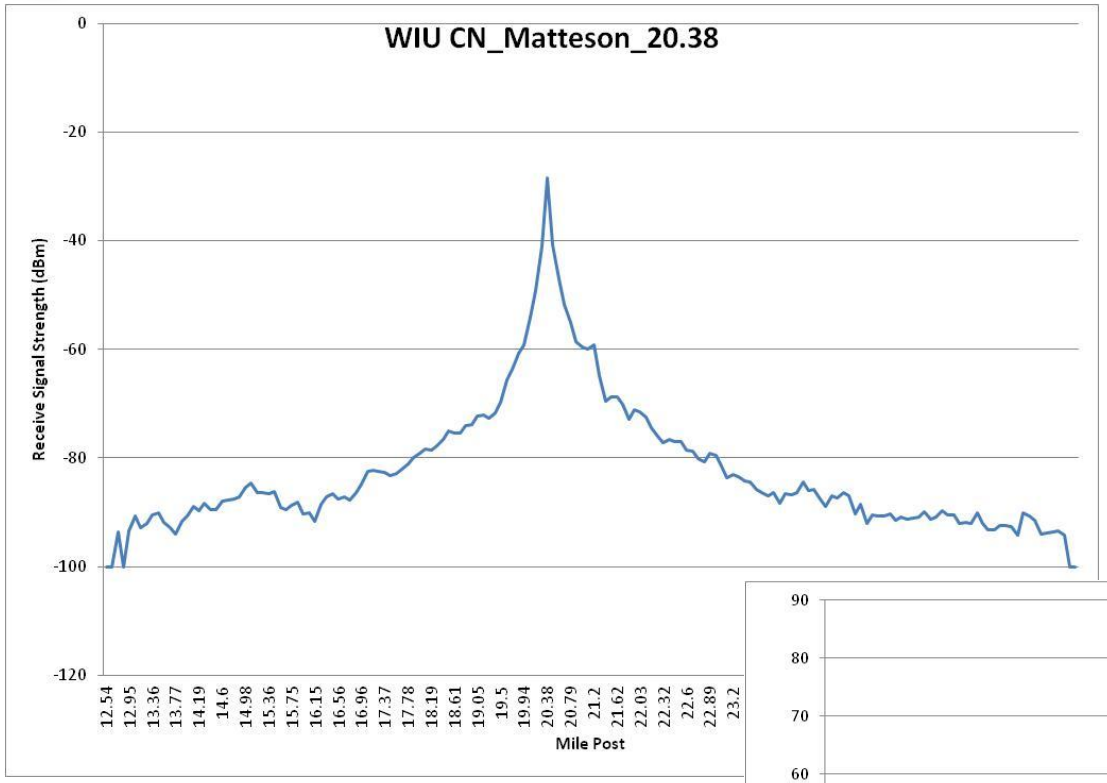


RF Analysis & Optimization
- Base Station Coverage
- Propagation & Interference Analysis
- High Availability (dual coverage)
- Load Balance
- Radio loading within design targets



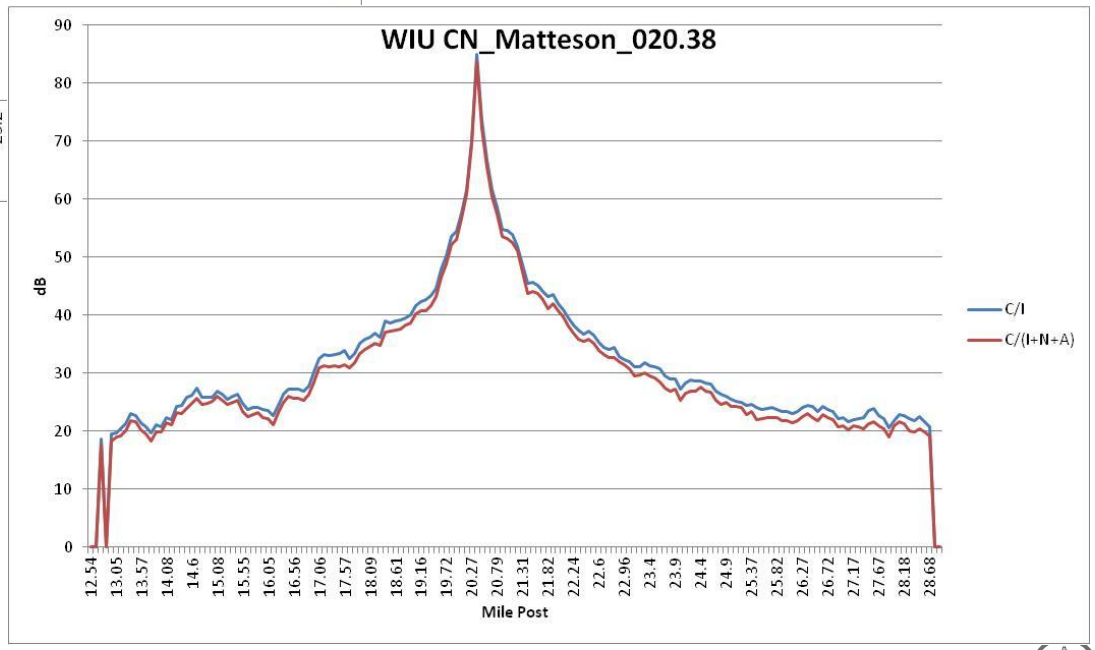
TTCI also has alternative method that uses Train Sheet data instead of RTC simulation

WIU coverage analysis



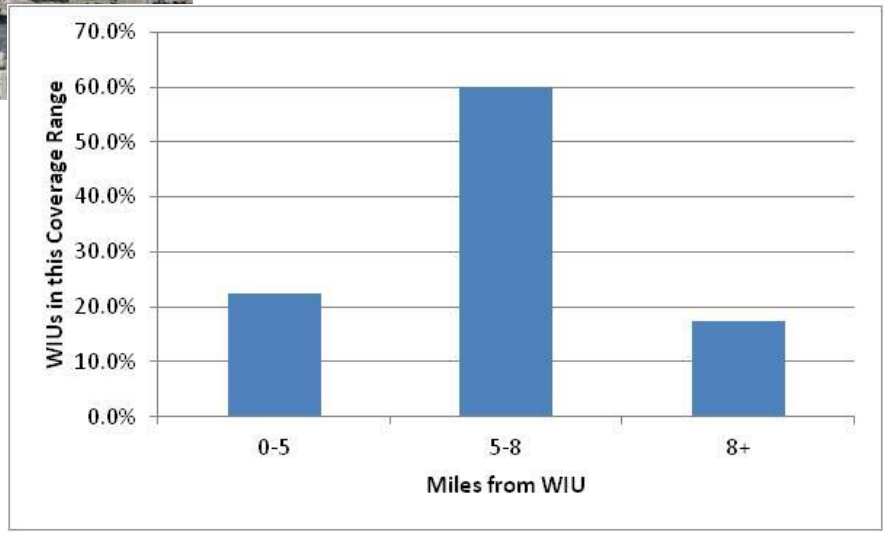
Example of a WIU with good coverage.

Mentum's Planet was used to predict coverage of WIUs



Wayside Relay Service (WSRS)

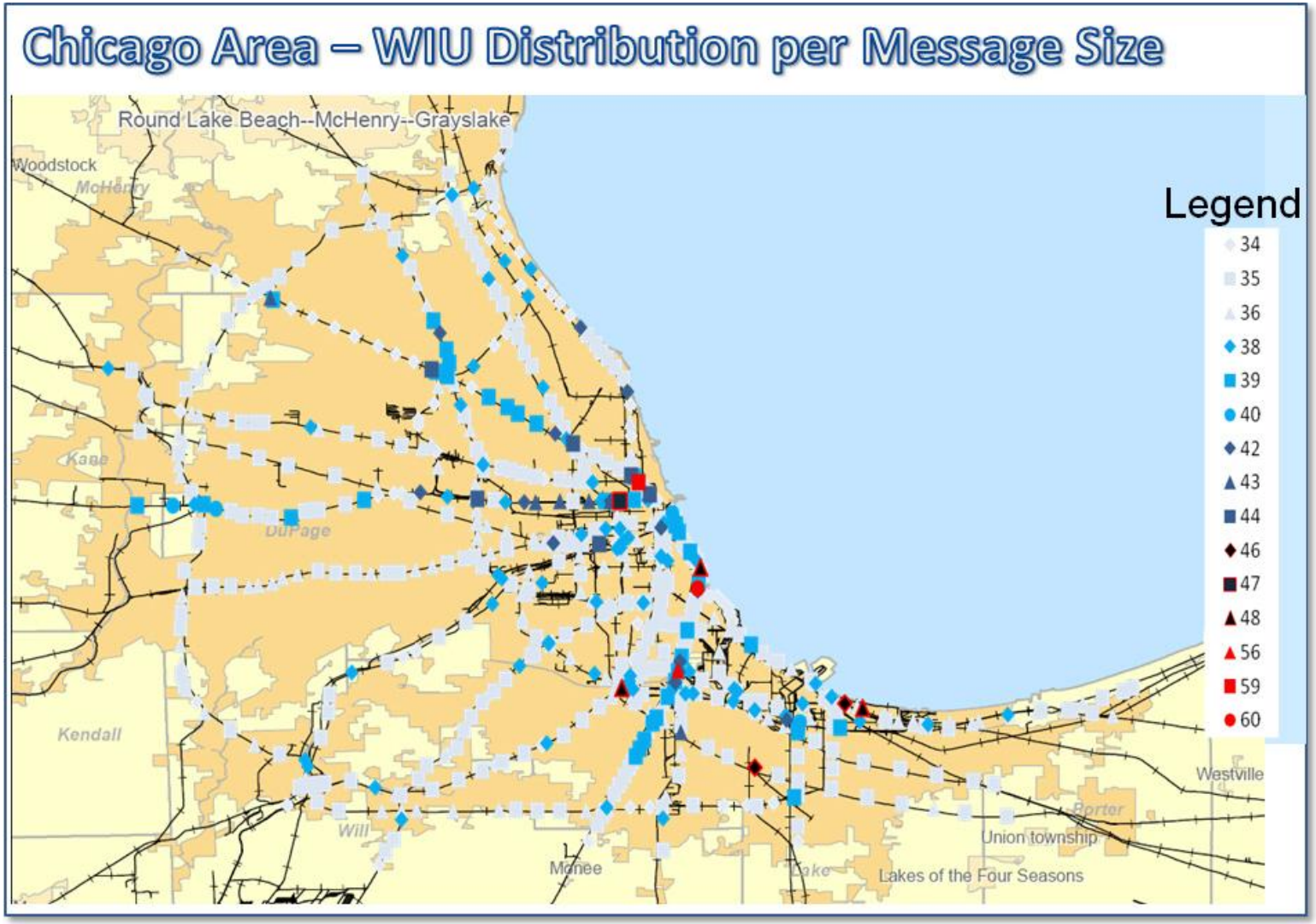
Downtown Chicago has scenarios with potential for RF Shadowing; e.g., between WIUs circled in red.



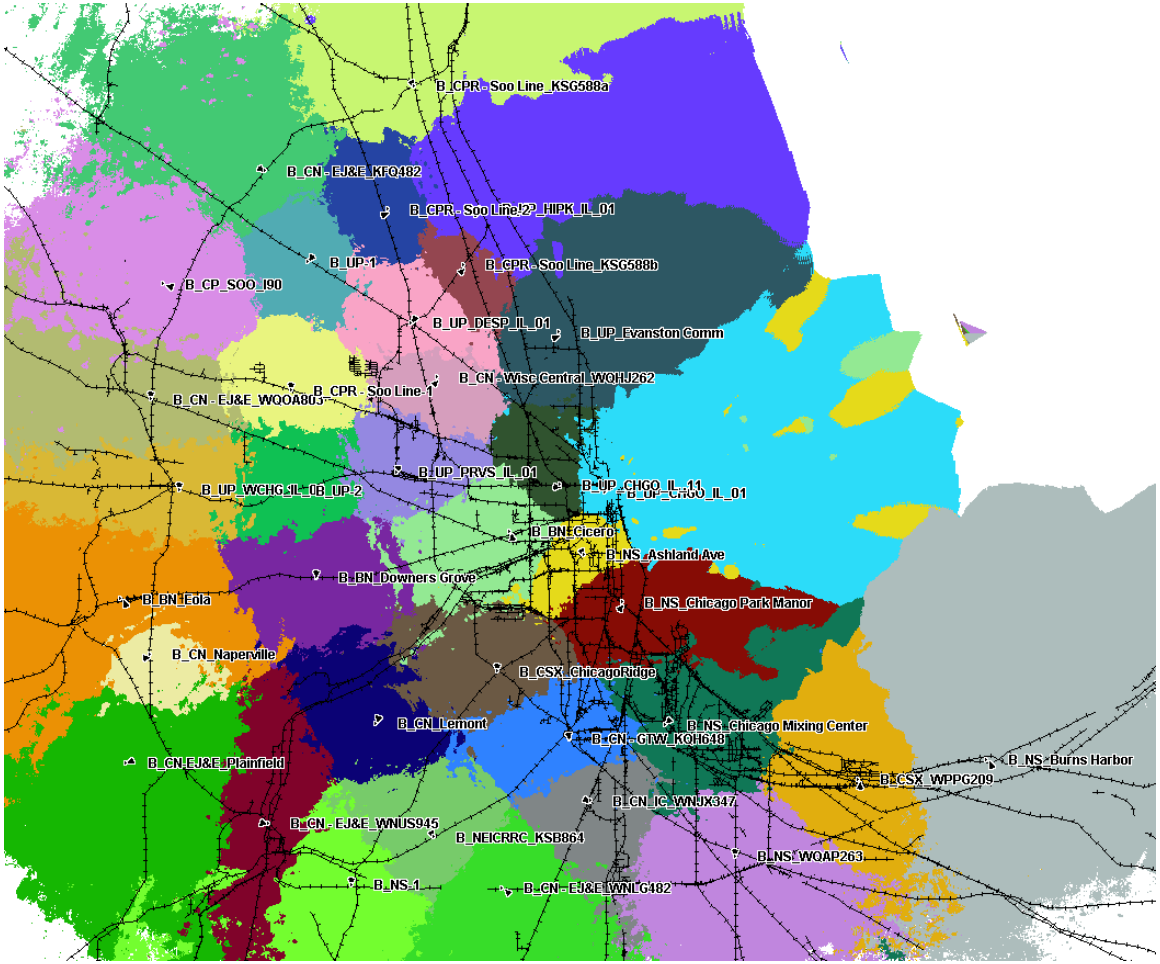
Preliminary WIU analysis results for Chicago:

- using full power & ht WIUs, ~18% need WSRS
- using restricted WIUs (221-222 MHz), ~23% need WSRS

Geographical Distribution of WIU Message Sizes

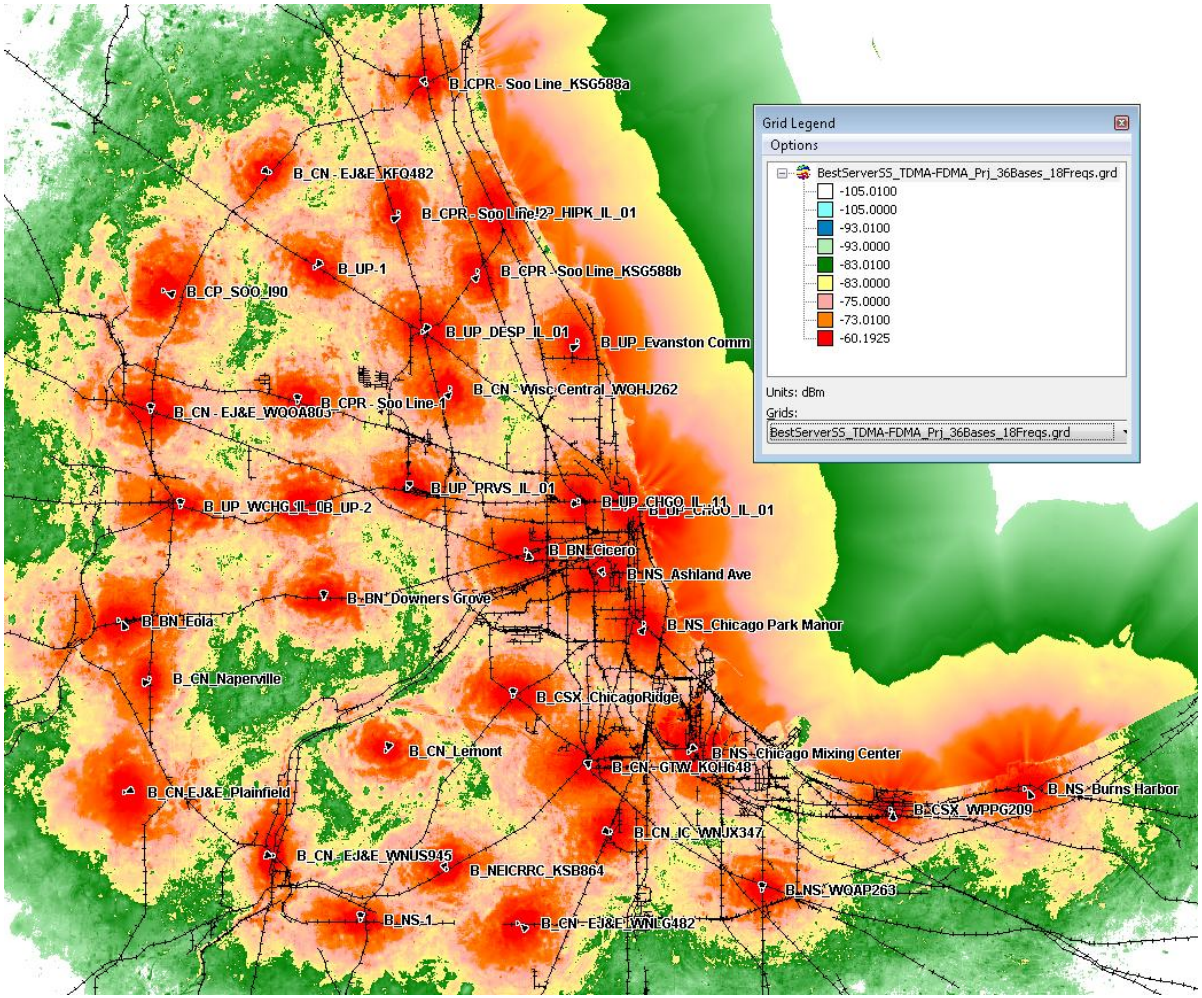


Preliminary Base Station best server plan used for Spectrum Estimation

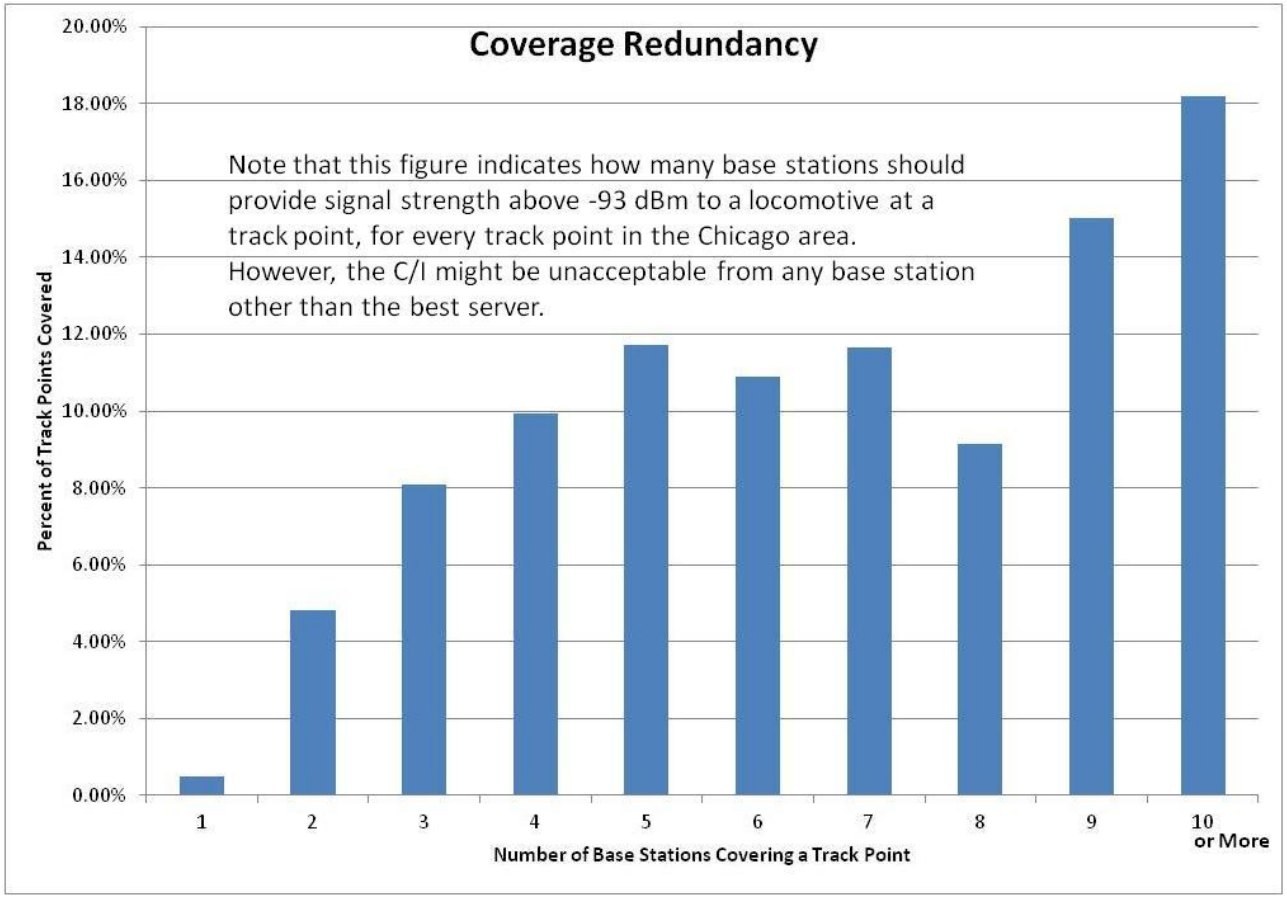


33 base stations selected from 89 candidates to achieve full coverage.
3 more needed to accommodate high traffic load downtown.
K=18 Frequency Reuse + 1 for nationwide Common Channel = 19 total.

Base Station Coverages



Degree of Base Station Coverage Redundancy



Conclusions

This Preliminary RF Spectrum Estimate has shown:

- The number of frequencies needed to cover the Chicago area with an acceptable level of interference, with less than fully redundant coverage, is approximately19, including one channel for use as the Common Channel.
- Given the PTC radio's required bandwidth of 25 kHz per frequency channel, the estimated amount of spectrum needed for PTC in Chicago is 19 channels x 25 kHz = 475 kHz.
- It is estimated that 18-23% of the WIUs in the Chicago area will require WSRS for a 5-mile range requirement, depending on EIRP and antenna height.

TTCI will conduct further modeling and analysis to complete and tune the design.

The above estimate of required number of channels and spectrum is based on preliminary analysis and considers factors currently determined.

Other factors not yet determined, such as more detailed radio network analysis and design that is currently underway as well as future changes to system requirements or design could impact the estimate.

The final result may require more or less total spectrum, but any changes to the total amount of spectrum required are not expected to be large, assuming that the requirements and assumptions do not change.

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